SMALL ARMS AMMUNITION PRODUCTION AND ACQUISITION STRATEGY FOR THE US ARMY

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The purpose of this research was to investigate the defense industrial base capability to support small arms ammunition production for the current and future operations, as well as an increase in force structure. Improved production and supply chain efficiencies have led to a reduction in government owned, contractor operated facilities from twelve facilities in World War II to only one today. These reductions were driven by a reduction in small arms ammunition requirements due to force reduction and periods of peace. However, today's current operations have dramatically increased these requirements beyond the current government owned, contractor operated production facility's production capability. Additionally, this study describes the contractor's supply chain used in manufacturing small arms ammunition. Historical data from World War II, post-Cold War operations, and Operations Iraqi Freedom and Enduring Freedom were used as part of the research tool to develop the argument and determine the primary question. The research proves current production meets the current requirements with the additional sourcing through alternative sources. Additionally, it provides information that estimates requirements for total war in a conventional environment. Recommendations for future projects of this nature are made.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

SMALL ARMS AMMUNITION PRODUCTION AND ACQUISITION STRATEGY FOR THE US ARMY, by Major Mark W. Siekman, 72 pages.

The purpose of this research was to investigate the defense industrial base capability to support small arms ammunition production for the current and future operations, as well as an increase in force structure. Improved production and supply chain efficiencies have led to a reduction in government owned, contractor operated facilities from twelve facilities in World War II to only one today. These reductions were driven by a reduction in small arms ammunition requirements due to force reduction and periods of peace. However, today's current operations have dramatically increased these requirements beyond the current government owned, contractor operated production facility's production capability. Additionally, this study describes the contractor's supply chain used in manufacturing small arms ammunition. Historical data from World War II, post-Cold War operations, and Operations Iraqi Freedom and Enduring Freedom were used as part of the research tool to develop the argument and determine the primary question. The research proves current production meets the current requirements with the additional sourcing through alternative sources. Additionally, it provides information that estimates requirements for total war in a conventional environment. Recommendations for future projects of this nature are made.

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ACRONYMS

AMC	Army Materiel Command
AR2B	Army Requirements Resourcing Board
ATK	Alliant TechSystems
CAA	Center for Army Analysis
COCOM	Combatant Command
DOD	Department of Defense
DODI	Department of Defense Issuances
GDOTS	General Dynamics Ordnance Tactical Systems
GOCO	Government-Owned, Contractor Operated
GWOT	Global War on Terror
JCIDS	Joint Capabilities Integration Development System
JMC	Joint Munitions Command
LCAAP	Lake City Army Ammunition Plant
MRP	Munitions Requirements Process
NC	Nitrocellulose
ONS	Operational Need Statement
OPLAN	Operational Plan
OSD	Office of the Secretary of Defense
OUSD(C)	Office of the Under Secretary of Defense (Comptroller)
PEO	Program Executive Office
POM	Program Objective Memorandum
QDR	Quadrennial Defense Review
QWARRM	Quantitative War Reserve Requirements for Munitions

RDTE	Research Development Test and Evaluation
RFAAP	Radford Army Ammunition Plant
SMCA	Single Manager for Conventional Ammunition
TAA	Total Army Analysis
TAMR	Total Army Munitions Requirements
TRADOC	Training and Doctrine Command

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CHAPTER 1

INTRODUCTION

> Ammunition and water are the only two items you cannot do without when locked in combat, the other necessities can be provided later--if you survive.[1]
>
> — R.J. Hammond

Purpose

This thesis examines the United States' small arms ammunition acquisition strategy in supporting the needs of US Army forces in current operational and training requirements, as well as for the increase in the future force. This thesis also compares the current operational requirements for small arms ammunition with present production capabilities and limitations with past production strategies. The purpose of the study is to determine if the defense industrial base should make any changes to the small arms ammunition acquisition strategy in order to support the future requirements of the US Army. Finally, is the national industrial base prepared to meet the small arms ammunition needs of the US Army.

Background

The United States continues to conduct full spectrum operations in two theaters of operation, contingencies around the world, and prepare and train for war. In January 2007, President Bush requested an authorization from Congress to grow the Army by approximately 75,000 Soldiers.[2] This growth, coupled with the continued high operational tempo of the operational force, requires additional resources to support it. At the heart of these required resources is ammunition. The planned growth in the force will place a greater demand for ammunition for operational and training requirements.[3]

In its current ammunition acquisition strategy for small arms, the United States utilizes the government-owned, contractor managed ammunition plant located at Lake City, Missouri. This strategy is driven in large part by the national industrial base's commitment to an ammunition supply chain driven by this ammunition plant's production capabilities. Any shortfalls in production levels would be outsourced to private commercial companies within the United States.[4] This chapter will focus directly on the agencies and services involved in small arms ammunition, the background of small arms ammunition production, issues impacting the current ammunition acquisition strategy, and finally the significance of the study.

Figure 1. Lake City Army Ammunition Plant
Source: Alliant TechSystems, http://www.atk.com/customer_solutions_armament systems/cs_as_fm_lcaap.asp (accessed 2 November 2009).

The center of gravity for the United States military is generating and sustaining combat power to support its strategic and operational reach. Combat power is generated

through the force management process. The Secretary of Defense has designated the Secretary of the Army as the Single Manager for Conventional Ammunition (SMCA), of which small arms ammunition is categorized.[5] This authority has been delegated to the Army Materiel Command (AMC). AMC is responsible for the research and development, as well as Life Cycle Management for small arms ammunition. They manage this responsibility for small arms ammunition through a strategy of government owned, contractor operated (GOCO) production at the Lake City Ammunition Plant. The production demands, until Operation Iraqi Freedom matured, were largely based on the Pre-War Stockages following the Cold War. However, under the new acquisition strategy, all production demand is now driven by current operational requirements.

The issues are the sustained production of small arms ammunition for the Army; the age of the production facilities; and whether the defense industrial base can sustain the growth of the Army coupled with the current missions, including operations in Iraq and Afghanistan.

The problem lies in the key principle of logistics, - responsiveness. Can the current industrial base capability –get the right stuff to the right location at the right time?" Logisticians will also argue this problem violates the laws of supply with no redundancy built into the system. Further explained, what does the Army do if the Lake City Ammunition Plant capability is degraded or worse yet, destroyed? The Army's small arms ammunition production is not only affected by Lake City facilities. As with any manufacturing system, the supply chain is an integral piece in the entire process. Lake City depends on outside sources for each component for each type of munitions produced. These sources include commercial suppliers from Allied nations, as well as the

Radford Army Ammunition Plant (RFAAP) located in the state of Virginia. The RFAAP is the sole producer of nitrocellulose, the essential ingredient for all explosives and propellants in small arms ammunition.[6]

Figure 2. Radford Army Ammunition Plant
Source: Alliant TechSystems, http://www.atk.com/customer_solutions_armament systems/cs_as_fm_raap.asp (accessed 2 November 2009).

Primary Research Question

Can the defense industrial base support small arms ammunition production for the current and future operations, as well as the increase in force structure?

Secondary Research Questions

1. What is the current small arms acquisition strategy?

2. What are the current and future requirements for small arms ammunition?

3. What production capability exists?

4. What were the historical production strategies?

5. What are the current facility and funding initiatives?

Significance

"We can win without food, we cannot win without ammunition." [7]

The significance of this study has potential catastrophic effects. The US Army is the greatest fighting force the world has ever seen, but it cannot continue to be dominating and successful without ammunition for the fight. If the authorization for a change in the way small arms ammunition is produced does not occur, then there is a great potential for this nation to be significantly impacted in its ability to win wars. If the nation cannot win its wars, then the status and influence as the global military hegemon will be lost as well.

Assumptions

1. The new National Security Strategy will continue to utilize military forces as an instrument to promote democracy throughout the world. This assumption leads to the US Army continuing to deploy forces worldwide to accomplish this strategy.

2. As Army forces are deployed to support this strategy, force protection measures will require small arms ammunition.

3. The Army's small arms ammunition requirements will remain relatively unchanged as compared to current operations in 2009, while the nation continues to conduct operations in Iraq, Afghanistan, and the Horn of Africa.

Definitions

Small Arms Ammunition: Ammunition profile consisting of 5.56mm, 7.62mm, and .50 caliber.

Small Arms Acquisition Strategy: Established guidelines in developing, manufacturing, purchasing, and resourcing small arms ammunition to the US Army.

Scope and Limitations

The author examined Army and Joint doctrines and research to analyze the current and future requirements of the US Army as well as past and current production measures to determine the impacts of the current acquisition strategy.

Limitations of this thesis include the accurate demand for small arms ammunition for training based on new doctrine focused on counter-insurgency. This limitation is also placed on the final disposition of the growth of the Army among the Active Component, Army National Guard, and the Army Reserves. Other limitations included acquiring current information from the Joint Munitions Center, the Radford Army Ammunition Plant, and the Lake City Ammunition Plant. Another limitation to this study is the limitations in national security issues surrounding the sole production facility for small arms ammunition. One final limitation is the author's time and experience in researching and analyzing data while attending the US Army Command and General Staff College.

Delimitations

The major delimitation was identifying the entire supply chain for each component for each type of munitions. This includes not only the direct supplier to the Lake City Army Ammunition Plant, but the suppliers of the aforementioned suppliers.

This identification would highlight the possible single sources of supply and the single points of failure within the supply chain.

Summary

The purpose of this chapter was to introduce the reader to the small arms ammunition strategy for the US Army and to provide a brief overview of how the national industrial base produces ammunition. The intent was to provide a basis as to what production capability exists to support this acquisition strategy. Additionally, the scope and limitations to this project were introduced. Chapter 2 will examine the secondary research questions in an effort to determine whether or not the industrial base production capability can support the Army's future growth and operational requirements.

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[1]R.J. Hammond, *Profile on Munitions*, AMCCOM Technical Library, 1980, 1.

[2]Department of the Army, *GrowThe Army*, 2007, http://www.army.mil/growthearmy/ (accessed 4 May 2009).

[3]*Associated Press,* "War Stretches Nation's Ammo Supply," 24 May 2007, 3.

[4]Richard. G. Palaschak, Director of Operations for the Munitions Industrial Base Task Force before the House Armed Services Tactical Air and Land Forces Subcommittee, 24 June 2004.

[5]Department of Defense, Department of Defense Directive 5160.65, *Single Manager for Conventional Ammunition* (Washington, DC: Government Printing Office, August 2008), 4.

[6]LTC Jon, Drushal, Commander of the Radford Army Ammunition Plant, Interview with Justine Barati, Joint Munitions Center, January 2009.

[7]The Lexington Institute, *Supplying Ammunition* (Arlington, VA: The Lexington Institute, 2007), 1.

CHAPTER 2

LITERATURE REVIEW

> We can win without food, we cannot win without ammunition.[1]
> — General Walton ―Bulldog" Walker, USA

The purpose of thesis is to investigate the question: can the defense industrial base support small arms ammunition production for the current and future operations, as well as the increase in force structure? By answering the primary research question, the author will also determine if any changes to the current small arms ammunition acquisition strategy will be required. The purpose of this chapter is to review the major sources of literature, including current policy and strategy, in an attempt to illustrate how this information can answer the primary research question.

First, a summary of the current acquisition process involving the US Army's Small Arms Ammunition Project Manager and the current contractor operating the government's sole small arms ammunition plant. This summary will include the contractor's business process and its supply chain management for small arms ammunition and the commodities involved in manufacturing. Next, the chapter will review the current requirements by the US Army and the current production capabilities meeting those requirements. The author will then illustrate the US Army's past production strategies and facilities. The chapter will then discuss funding for small arms ammunition production and the Government Owned, Contractor Operated (GOCO) facility used in manufacturing these munitions. Finally, the chapter will summarize alternative options provided within the ammunition industry.

Current Acquisition Strategy

The current acquisition strategy for small arms ammunition derives from the National Military Strategy as well as current operational and training requirements. The responsibility for supplying munitions to the military falls to the U.S. Army. The Secretary of Defense has identified the Secretary of the Army as the Single Manager for Conventional Ammunition (SMCA).[2] As the name suggests, the SMCA is responsible for ensuring that all branches of the U.S. military are supplied on a timely basis with the conventional munitions they require.[3] The SMCA is responsible for establishing the requirements for production, the funding and the required delivery date.[4] The SMCA delegates this responsibility to the US Army Materiel Command (AMC). The Joint Munitions Command is the major subordinate command providing the small arms ammunition life cycle management for logistics sustainment, readiness and acquisition for the US Army and the sister services.[5] In accordance with Department of Defense Instruction 3000.4, Department of Defense Munitions Requirements Process (MRP), JMC is required to develop the munitions requirements twice a year.[6] Through their deliberate planning process, the Joint Munitions Command uses the Quantitative War Reserve Requirements for Munitions (QWARRM) process to develop the War Reserve and Operational requirements.[7] Figure 3 displays the QWARRM development. It revolves around detailed, complex modeling conducted by the Center for Army Analysis, which takes into account input from Strategic Planning Guidance; Combatant Commander's Operational Plans; current and projected threats; projected force structure for the current Program Objective Memorandum (POM); approved munitions past Milestone B;[8] munitions caps; Training and Doctrine Command (TRADOC) approved

combat loads; munitions and system performance; and other factors. [9] QWARRM is the Army portion of the Department of Defense Issuances (DODI) directed Munitions Requirements Program in support of Joint analysis.[10] The Joint Munitions Command uses the mandates prescribed in the Department of Defense Issuances (DODI) and integrates them with the Army simultaneity stack of conflict and the resourced force structure in the Total Army Analysis (TAA).[11] Most of the requirements derive from the Training and Doctrine Command's (TRADOC) Munitions Combat Load Study against the resourced force structure.[12] The Army has a process for long-term POM requirements and for short-term urgent requirements. Long-term requirements are based upon TRADOC Capability Gap Analysis. As gaps become identified, TRADOC Combat Developers write Joint Capabilities Integration Development System (JCIDS)[13] capabilities development documents for approval through the G-37/CI Capabilities Integration Office. If the capability document is approved, TRADOC Combat Developers also propose combat load totals for each munitions or weapon to the G-37/TRA (Army Munitions Management Office)[14] Council of Colonels. If the Council approves the combat load total, it is used during modeling of Army war reserve munitions requirements.[15]

Army Commands may also submit operational needs statements for short-term, one-time urgent requirements to the Army Requirements Resourcing Board (AR2B). If TRADOC gets JCIDS approval for these capabilities, they also are utilized during modeling of Army war reserve munitions requirements. The Center for Army Analysis (CAA) models the Army's war reserve requirements. During modeling, CAA takes into account OSD and Joint Staff guidance, COCOM OPLANs, approved TRADOC combat loads, and the projected force structure for a particular OPLAN or mission. CAA

provides its modeled requirements back to G-37/TRA where they are finalized and vetted with other key players in the Munitions Enterprise. Once the Army G-3 approves the Total Army Munitions Requirements (TAMR), the requirements are submitted for resourcing in the POM. Once funds are available, small arms ammunition becomes procured and produced at the Lake City Army Ammunition Plant.[16]

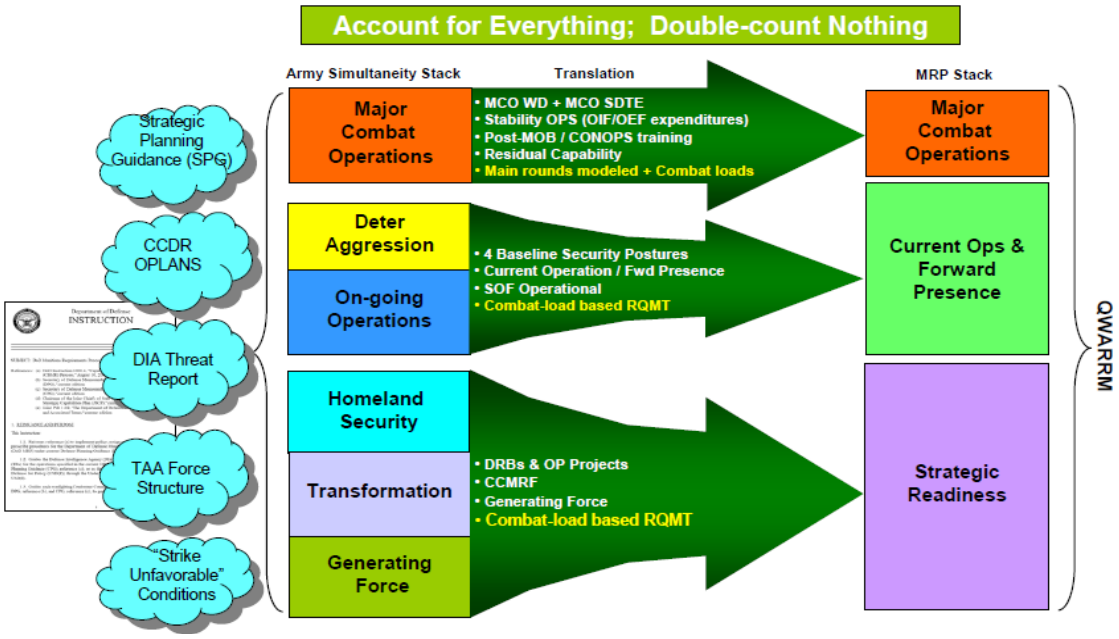

Figure 3. QWARRM
Source: Robert Grubbs, Deputy Division Chief, Department of the Army G3 Munitions, US Army Munitions Brief, www.dtic.mil/ndia/2008psa_peo/Grubbsday2.pdf (accessed 27 August 2009).

The Joint Munitions Command also integrates the training requirements for munitions. These requirements reflect support to home station, institutional, and deployed training for a Program Objective Memorandum period.[17] The last type of requirements the Joint Munitions Command uses to determine the Total Army Munitions

Requirements include testing requirements. These requirements reflect munitions required to support stockpile reliability and Research Development Test and Evaluation (RDTE) testing.[18]

Figure 4 provides a summary of how the Joint Munitions Command uses the War Reserve and Operational requirements developed via the QWARRM process coupled with training and testing requirements to provide the Total Army Munitions Requirements (TAMR).[19]

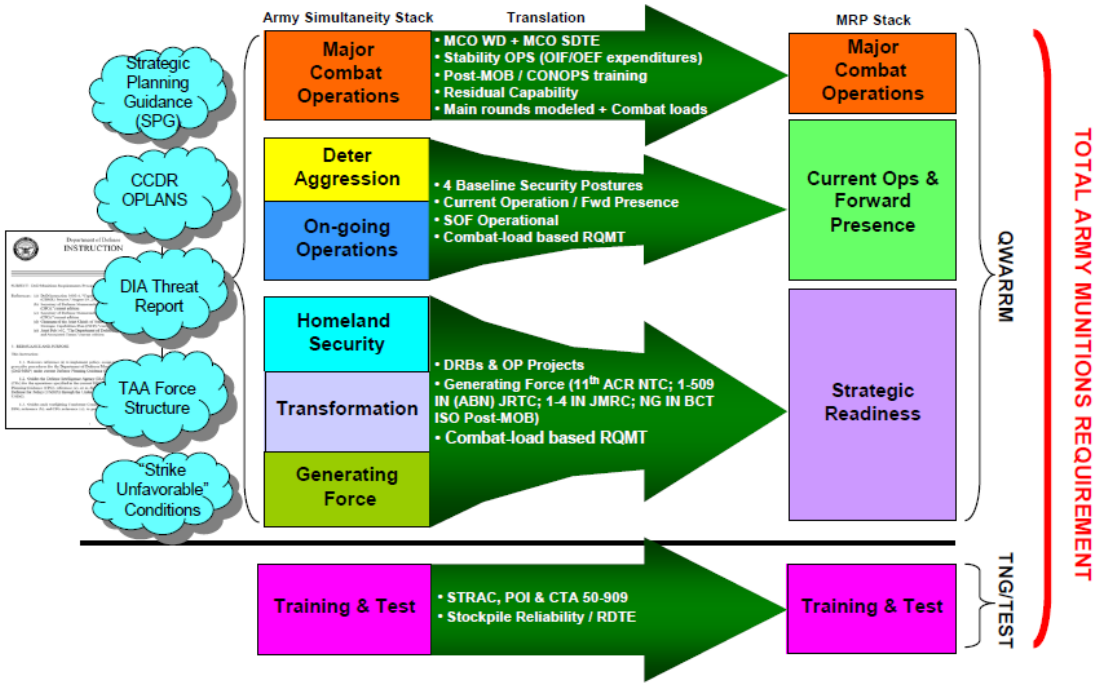

Figure 4. Total Army Munitions Requirement
Source: Robert Grubbs, Deputy Division Chief, Department of the Army G3 Munitions, US Army Munitions Brief, www.dtic.mil/ndia/2008psa_peo/Grubbsday2.pdf (accessed 27 August 2009).

The Joint Munitions Command submits the small arms ammunition requirements to the Lake City Army Ammunition Plant for production. These requirements are the driving factor for production output at Lake City. The large amount of requirements and the flexibility in the process make it essential to have anticipated requirements in outlying years, as prescribed in the POM cycles. As each fiscal year becomes closer to the current year, these requirements are continuously refined in order to produce the correct amount of small arms ammunition.[20]

The current production process for small arms ammunition resides within the Lake City Army Ammunition Plant (LCAAP) located just outside of Kansas City, Missouri. Established in December of 1940 by Remington Arms as a small arms ammunition manufacturing and testing facility for the US Army, LCAAP is currently the largest provider of small arms ammunition to the US Army. The facility encompasses almost 4,000 acres and produces small arms ammunition in the following calibers: 5.56mm, 7.62mm, and .50 caliber.[21] These ammunition types are the predominant munitions used in every unit within the US Army, both for individually assigned weapons, as well as machine guns. These calibers are also the focus of this study. LCAAP not only manufactures these calibers of munitions, but also continues to test and provide research and development. Alliant Techsystems (ATK) now operates this GOCO facility for the US government. As a GOCO, the facility is commanded by a US Army Lieutenant Colonel, but ATK is responsible for production operations and capabilities. This relationship allows the US government to reduce manpower costs and invite private sector business initiatives to promote efficiency and production improvement.[22]

Small Arms Ammunition Commodities

Each small arms ammunition cartridge (single round) contains different components. The main ammunition used by virtually every US Army Soldier and US Marine is the 5.56mm cartridge. Its design entails the cartridge case, the bullet or shot, propellant and primer. Each of these components are derived from different commodities. As seen in Figure 5, the cartridge case is made of brass, the bullet is typically lead core, the propellant and primer. The US Army requires Alliant Techsystems to maintain a minimum of three suppliers for each of the components commodity.[23]

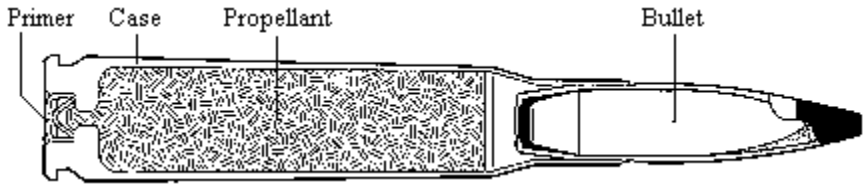

Figure 5. Cartridge Components
Source: RKBA.Org. http://rkba.org/guns/principles/definitions/ammunition.html, (accessed 18 August 2009).

The brass for the cartridge case is mainly supplied from companies within the continental United States. LCAAP has also taken initiatives to recycle unused and waste brass during the manufacturing process to reduce costs. LCAAP purchases brass in the form of brass case cups and bullet jacket cups from a United States based source. During the manufacturing process, these cups are then pulled from their original configuration to a complete case for the small arms ammunition cartridge type. Alternative suppliers have been identified, however they account for less than five percent of the total purchased.[24]

The bullet is composed of a steel penetrator and lead, however, recent research and development is focusing on a lead-free bullet. This research is mainly to support environmental practices being applied at the various training installations for the US Army, as well to offset the resources and work required to effectively eliminate the environmental claims assessed at installations identified to be inactivated by the Base Realignment and Closure initiatives by the US Congress. Lake City Army Ammunition Plant does manufacture over 99 percent of its bullets at the plant, but it does purchase the lead from a United States based source. Using a proprietary process, this primary supplier extracts lead from recycled batteries as its main source. Alternate suppliers do exist for the Lake City Army Ammunition Plant to purchase. Also, the bullet is comprised of a steel penetrator. This steel is purchased from two main sources located in the United States.[25]

The main ingredient used in all small arms ammunition propellants is nitrocellulose. The Radford Army Ammunition Plant in Virginia is the sole producer of the essential ingredient for all propellants used throughout the US Army's ammunition industrial base. It has an acid-concentrator facility that produces the nitric and sulphuric acids that, when combined with cellulose in a one-of-a-kind facility at Radford, make nitrocellulose. Ninety-nine percent of all small arms ammunition used in Afghanistan and Iraq contain nitrocellulose produced at this facility. The US Army has plans to construct a new facility sometime between 2010 and 2013 to replace the current production facility built in 1941.

Finally, the primer on most cartridges is made from over thirteen different chemicals, which are mixed at the Lake City Army Ammunition Plant. LCAAP

manufactures the primers for all small arms ammunition produced at their facility. Alliant Techsystems continues to seek additional sources of supply for the primer mix chemicals. All sources are based in the United States, however, the country of origin for the chemical commodities reside in the United States, Canada, Europe, Mexico, India, Brazil, and China.[26]

One final component for machine gun ammunition involves linkage belts. These are the metal linkages that allow automatic weapons to continue to fire as the ammunition is linked in belts. Prior to Operation Iraqi Freedom, the Lake City Army Ammunition Plant relied on suppliers for linkage belts involving the 5.56mm, 7.62mm, and the .50 caliber. Due to the large increase in demand, the plant invested in upgrading the facilities and the manufacturing equipment. This included purchasing, moving, and installing the sole surviving production line for linkage belts for 5.56mm, 7.62mm, and .50 caliber machine guns. This solution was part of the overall effort to meet the required demand for more ammunition during Fiscal Year 2004 and on.

These commodities are all involved in making the products specific to caliber type. For the 5.56mm family, Lake City manufactures three types: ball, tracer, and blank. These three types consist of seven cartridge models comprised of one casing type made up brass, one primer, five bullet types and 4 different propellant mixtures.[27]

The 7.62mm family consists of six different types manufactured in six cartridge models. Only one brass casing type is used in the 7.62mm family, but five different bullet variants are used. Finally, the propellant is specific to the cartridge model and can be used from five types.[28]

The Lake City Army Ammunition Plant also makes variants for the .50 caliber family class. Eight variants of the .50 caliber are produced for ten cartridge models. Like the other caliber families, all of the different .50 caliber cartridge models are made of the same brass casing, as well as use the same type of primer. Nine different bullets are used in the variants with five differing propellants.[29]

Current Requirements and Production Capabilities

The current small arms ammunition production capabilities are limited only to the Lake City Army Ammunition plant for this study. Although LCAAP is the sole surviving government owned contractor operated small arms ammunition facility, it has taken many initiatives to improve production capability and efficiency. Alliant Techsystems uses a Process Improvement Management technique styled after the Toyota Corporation.[30] This has enabled the contractor to reduce costs associated with manufacturing and, at the same time, increased production to meet the demands from the field.

Figure 6 shows the levels of production by the Lake City Army Ammunition Plant. The US Army almost doubled total requirements for small arms ammunition from 2003 to 2004. As previously stated, the Joint Munitions Command utilized the deliberate planning process utilizing the POM cycle, as well as a short-term procedure allowing a COCOM to submit a one-time operational needs statement (ONS).[31] This scenario occurred in 2004 when LCAAPs production requirements increased from 559 million rounds in 2003 to 1.192 billion rounds in 2004.

This increase in LCAAPs production caused ATK and the US Army to analyze the facilities and conduct a modernization program to increase efficiency and

production.[32] This dilemma was initially resolved with the increase in operating hours of the plant and instituting another work shift for production.

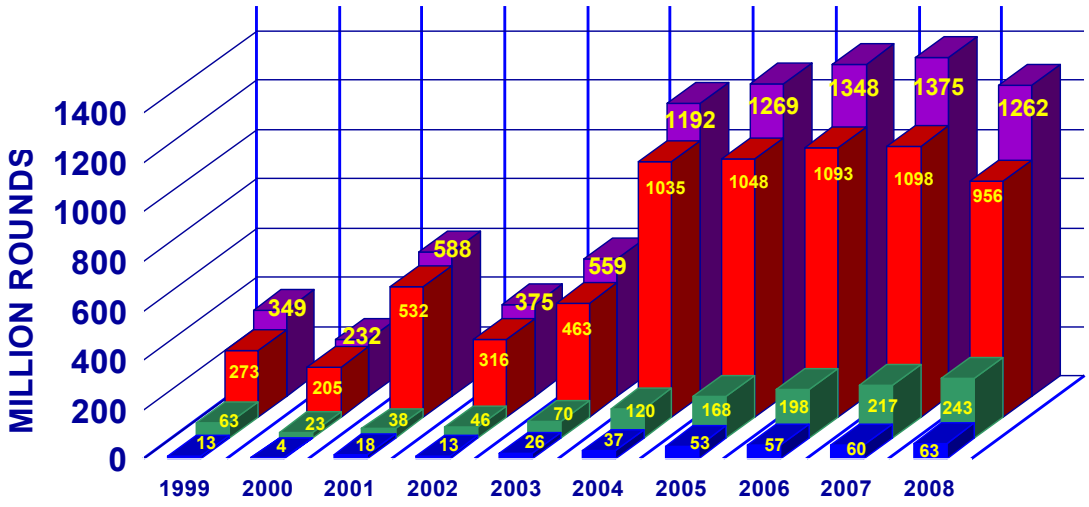

Figure 6. LCAAP Production

Source: T. Blose, Production Base Realities, Briefing (slide 1), Picatinny Arsenal, NJ, US Army Joint Munitions Command. February 13, 2002.

As current operations continue in both Afghanistan and Iraq, as well as around the world in the War on Terror, the Lake City Army Ammunition Plant continues to be the sole producing facility for small arms ammunition. Despite the current modernization programs and initiatives by both the US Army and Alliant Techsystems, the plant has a maximum production capability of 1.6 billion small arms ammunition rounds annually.[33] The Joint Munitions Command does utilize outside sourcing alternatives to provide an

additional 300 million small arms ammunition rounds annually. This is procured through a current contract with General Dynamics Ordnance Tactical Systems (GDOTS). GDOTS acquires this ammunition from commercial producers of small arms ammunition.[34]

Historical Production Strategies

> A nation such as the United States cannot afford to scrap that production capacity over and over again. This time these plants ought remain in stand-by for years to come and, most important, plant and equipment should be rehabilitated and renovated periodically.[35]

Since the country's inception, post war planners have continuously deactivated and diminished the national industrial base, especially for the production of small arms ammunition. Although numerous reasons are given as to why it is done, it usually is narrowed down to a matter of money. The nation and its government no longer see the need, nor do they have the budget to sustain complex and robust war facilities when war no longer exists.

During WWII, the US government mobilized the industrial base to fill the staggering demands for small arms ammunition from the operational level. The national strategic strategy was to force Germany into total capitulation in a concerted effort with Great Britain and the Soviet Union. It also entailed supplying these Allies with equipment and ammunition. These requirements for small arms ammunition peaked at 1.8 billion rounds produced per month. This national industrial base for ammunition production included eleven GOCOs and three COCOs to support the war demands.

Figure 7 illustrates the locations of the eleven GOCO ammunition plants that produced the bulk of the war requirements for small arms ammunition, including .30

caliber munitions. Only the Twin Cities Ordnance Plant, located near St. Paul, MN, the Frankford Arsenal, located near Philadelphia, PA and the Lake City Army Ammunition Plant were used after WWII. Out of these three, only the Lake City Army Ammunition Plant remains in operation for small arms ammunition.

Figure 7. WWII Government Owned, Contractor Operated Ammunition Plants
Source: International Ammunition Association, Inc., no. 426 (July/August 2002)

Figure 8 illustrates the location of the three Government-Owned, Contractor-Operated ammunition production facilities who received government contracts during

WWII for small arms ammunition production. Winchester Repeating Arms, located in Connecticut, continued to operate under government contract until 1972.

Figure 8. WWII Contractor Owned, Contractor Operated
Source: International Ammunition Association, Inc., no. 426 (July/August 2002)

Shortly after the end of World War II, the US Army closed many of its facilities or discontinued the war production contracts. This reduction in the industrial base for small arms ammunition left the US Army with six operational facilities during the Korean Conflict. These facilities were the Lake City Ordnance Plant (LCAAP today), the St. Louis Ordnance Plant, the Twin Cities Ordnance Plant, the Frankford Arsenal, the

New Haven contract facility (Winchester Repeating Arms Company) and the Bridgeport contract facility (Remington Arms Company).

Despite the reduction in small arms ammunition production facilities, the national industrial base met the required monthly demand of approximately 100 million rounds of small arms ammunition.[36]

This reduction in manufacturing facilities occurred again in between the Korean Conflict and the Viet Nam war. However, due to an increase in production efficiency the national industrial base was able to meet the required monthly demand of approximately 100 million rounds of small arms ammunition with only five facilities. Out of the Korean Conflict's six facilities, the St. Louis Ordnance Plant converted to large caliber ammunition. The US Army continued its two contracts with the Remington Arms Company and the Winchester Repeating Arms Company for small arms ammunition.[37]

The aftermath of the Viet Nam War left the US Army as a "hollow Army," as quoted by then Army Chief of Staff, GEN E. C. Meyer.[38] This "hollowing out" included the national industrial base. Despite the US Army's War Stockage levels being able to support major combat operations in Europe, it practically brought the production base to a standstill. With the exception of the Lake City Army Ammunition Plant, all other government owned facilities and contracted production for small arms ammunition ceased. The requirements for small arms ammunition continued to decrease until the initiation of Operation Enduring Freedom and Operation Iraqi Freedom.[39] This history of the national industrial base's small arms ammunition production is illustrated in figure 9.

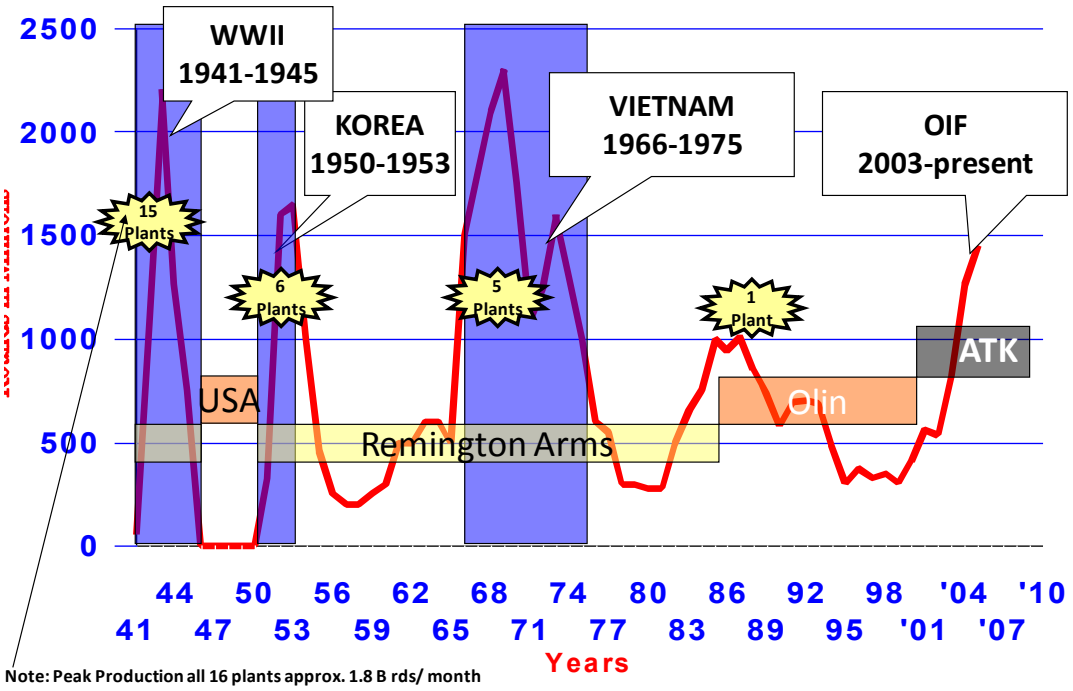

Figure 9. Historical Small Arms Ammunition Production[40]
Source: William J. Sanville, Project Manager, Maneuver Ammunition Systems, 2003 Briefing on state of small caliber ammunition.

Current Funding

Funding for small arms ammunition is derived from the Program Objective Memorandum (POM) submissions. The POM occurs every two years and is a five-year outlook for budget requirements. The US Army also received funding for small arms ammunition through the Global War on Terror (GWOT) supplemental funding bills. After receiving the funding from the Office of the Under Secretary of Defense (Comptroller) OUSD (C) for use in procuring ammunition, the US Army submits its request to the Program Executive Office (PEO) for Ammunition. As the PEO Ammo is an Army organization, it provides an allotment to the Program Manager, Maneuver Ammunition Systems to obligate the funds within the specified amount. This Program

Manager then directs the Joint Munitions Command to issue procurement work directives to the Picatinny Contracting and Commerce office.[41] The total amount of GWOT funding provided to the US Army for FY 2007 for Small Arms Ammunition was $290,950,000.[42]

Prior to GWOT supplemental funding bills, the US Army relied on the standard POM submission for the budget to gain funding for small arms ammunition procurement. As such, over 95 percent of production dollars are allocated to the Lake City Army Ammunition Plant.[43] Figure 10 illustrates the needed funding from supplemental bills to be able to meet total small arms ammunition production requirements. Although Figure 8 illustrates requirements for all services, it is indicative of the services' inability to accurately forecast funding requirements based on operational changes. As stated previously, Fiscal Year 2004 and beyond presented a dramatic rise in small arms ammunition requirements due to Operation Iraqi Freedom. As the operations in Iraq decrease and forces are drawn down, it will continue to be problematic for ammunition forecasters.

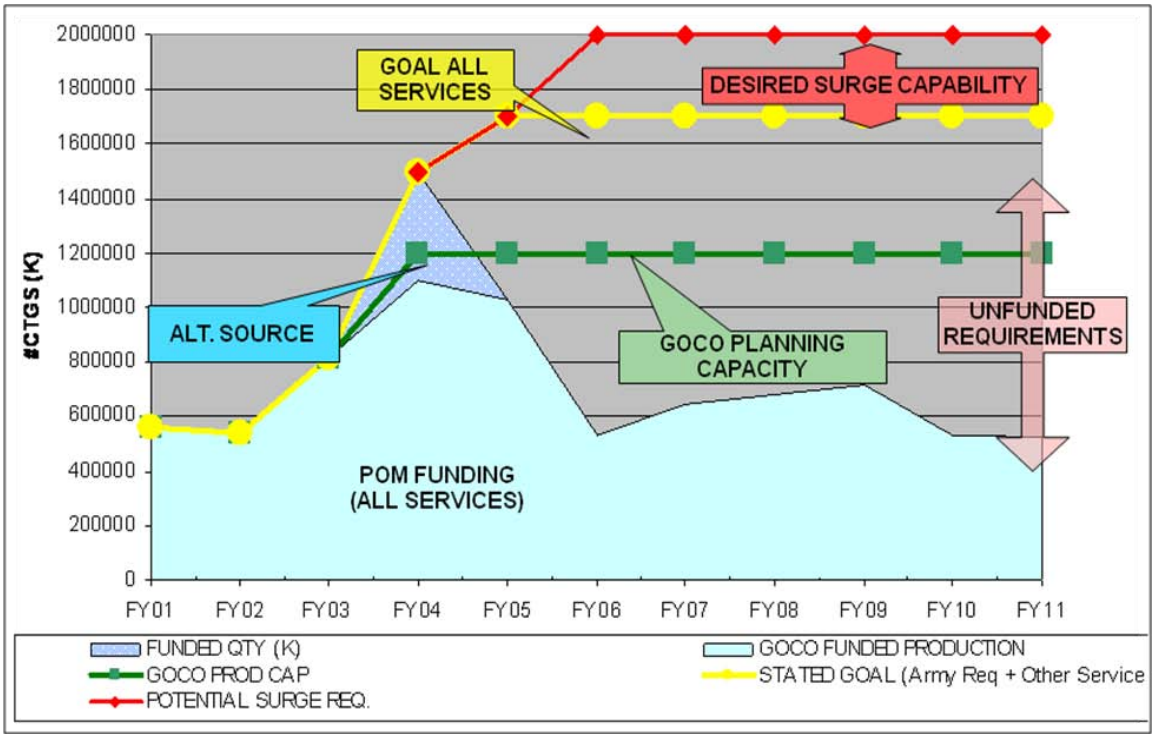

Figure 10. Small Arms Ammunition Requirements and Funding
Source: William J. Sanville, Project Manager, Maneuver Ammunition Systems, 2003 riefing on state of small caliber ammunition.

6. Alternative Acquisition Strategies.

Due to the increased demand for small caliber ammunition, the subject of my research has undergone some scrutiny by the Department of Defense and the US Congress to ensure all warfighters are sustained properly. Differing schools of thought exist on how to properly sustain training and operations with small caliber ammunition. After the end of the Cold War, the DoD went through a downturn in its defense industrial base. This was primarily due to decreasing budgets, but also with increasing efficiency and technological advances that improved productivity. Also, as the Army was reduced in size and the Soviet threat defeated, the demand for small caliber ammunition was also decreased. This contraction of the defense industrial base allowed those policymakers to

believe a leaner, lighter industrial footprint would be able to produce the appropriate quantities to meet the demand. Others believed the industrial base footprint should remain the same to maintain the proper capability in times of war. In the end, a compromise was reached with one ammunition plant remaining active, the Lake City Ammunition Plant, and a series of others minimally maintained with production operations ceasing.[44]

There continues to be a debate on how to properly acquisition small arms ammunition for the force. The requirements process itself is not in question, but the strategy on production is. Currently, the US Army relies on the Lake City Army Ammunition Plant for a maximum of 1.6 billion rounds annually, with a potential acquisition of another 300 million rounds from commercial contracted sources. Members of the acquisition community, along with Alliant Techsystems (ATK), are actively pursuing a strategy involving 100 percent contracted sources for small arms ammunition.[45] This was reinforced by the Deputy Secretary of Defense declaring that ~~"~~to the maximum extent feasible, the Army will transition government-owned ammunition production assets to the private sector".[46]

An alternative strategy to the above stated strategy is starting to exist. One such strategy derives from a student at the Defense Acquisition University, COL John Ferrari, USA. His alternative model focuses on reversing the trend towards privatization based on historical private sector behavior in declining industries. [47] COL Ferrari argues the munitions industrial base fits the definition of a declining industry in that revenues have decreased by almost 80 percent, and more than 70 percent has disappeared from 1985 through 2001.[48] Although revenues have temporarily increased due to current operations,

the increase is only temporary. Based on this declining industry is subject to national policy that blocks overseas outsourcing, the military's total reliance on the private sector is highly problematic and dangerous.[49]

This chapter's goal was to review literature that related to the primary and secondary research questions in this thesis. The primary research question is: Can the defense industrial base support small arms ammunition production for the current and future operations, as well as the increase in force structure? First, the current acquisition strategy was presented detailing the requirements process to production. Each of the secondary questions was highlighted with viewpoints from various researchers and authors. Finally, alternative views to the current acquisition strategy were presented. The following chapters will add to the information gained in this literature review by using a methodology associated with the force sizing construct model, as well as training the entire force, including full mobilization The status of the current production strategy will be presented. Finally, an analysis of this thesis will be given and recommendations will be suggested on future strategies and additional research needed.

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[1]Ibid.

[2]Department of Defense Directive 5160.65, 4.

[3]Alan R. Beuster, "Update on Industrial Issues," Presentation to ICAP, 12 February 2002, 4.

[4]Department of Defense Directive 5160.65, 4.

[5]Joint Munitions Command website, www.jmc.army.mil (accessed 9 August 2009).

[6]Department of Defense, Department of Defense Instruction 3000.4, *Defense Munitions Requirements Process (MRP)* (Washington, DC: Government Printing Office, 2003), 21.

[7]Ms. Linda Szabaga, Lead Inventory Management Specialist, Joint Munitions Command, Small Caliber Division, Rock Island Arsenal, IL, Electronic correspondence with author, 7 August 2009, explaining the munitions requirements process.

[8]Milestone B is part of the Army Flow Model in the Life Cycle Management of any procured item for the US Army.

[9]Szabaga.

[10]Department of Defense Directive 5160.65, 4.

[11]Ibid.

[12]Ibid.

[13]Szabaga.

[14]The G-37/TRA (Army Munitions Management Office) is a subordinate office under the Department of the Army G-37 Training Directorate.

[15]Robert Grubbs, Deputy Division Chief, DA G3 Munitions. US Army Munitions Brief, http://www.dtic.mil/ndia/2008psa_peo/Grubbsday2.pdf (accessed 27 August 2009).

[16]Szabaga.

[17]Ibid.

[18]Ibid.

[19]Ibid.

[20]Ibid.

[21]LTC Christopher Day, LCAAP Commander, Briefing to author during LCAAP tour, May 2009.

[22]Ibid.

[23]Ibid.

[24]Ibid.

[25]Ibid.

[26]Ibid.

[27]Ibid.

[28]Ibid.

[29]Ibid.

[30]Ibid.

[31]Szabaga.

[32]Day.

[33]Ibid.

[34]Larry Smith, LCAAP Purchasing Manager (ATK), Briefing to author during LCAAP tour, October 2009.

[35]Harry F. Ennis, *Peacetime Industrial Preparedness for Wartime Ammunition Production*, Defense Logistics Studies Information Exchange, 1980, 51.

[36]William J. Sanville, Project Manager, Maneuver Ammunition Systems, 2003 Briefing on State of Small Caliber Ammunition, Picatinny Arsenal, New Jersey, US Army Joint Munitions Command.

[37]Ibid.

[38]George C. Wilson, ―Joint Chiefs of Staff Break With Carter On Budget Planning for Defense Needs,‖ *Washington Post,* 30 May 1980, A1.

[39]Sanville.

[40]Ibid.

[41] *Small Arms Ammunition Fund Management in Support of GWOT*. Inspector General, United States Department of Defense. Report No. D-2009-006. October 20, 2008.

[42] Ibid.

[43] Blose, T. (February 13, 2002). Production base realities. Briefing (slide 1), Picatinny Arsenal, NJ: US Army Joint Munitions Command.

[44] *Grow The Army.* 2007. http://www.army.mil/growthearmy/ (accessed May 04, 2009).

Hix, William, David Oaks, Bruce Held, Edward Keating, Michael Hynes, and John Bondanella. *Options for Managing the Army's Arsenals and Ammunition Plants.* Rand Arroyo Center, 2003.

[45] LTC Day

[46] Department of Defense. (August 1, 2008). *Single Manager for Conventional Ammunition (SMCA)* Department of Defense Directive 5160.65

[47] COL John Ferrari, USA. *Transferring Conventional Munitions Industrial Base Capabilities to the Public Sector.* Defense Acquisition University. 2009.

[48] Ibid.

[49] Ibid.

CHAPTER 3

RESEARCH METHODOLOGY

The primary research question is: Can the defense industrial base support small arms ammunition production for current and future operations, as well as the increase in force structure?

In this chapter, the author will identify the criteria to compare and analyze in the research methodology. Supply and demand are the basis for finding the appropriate answer to the primary research question. In logistical terms, supply and demand represent capabilities and requirements. The author will identify what is the requirement (demand) of the industrial base moreover, what amount can they produce (supply).

In this methodology, a table of ammunition management will identify the small arms ammunition requirements based on three time periods. The Post-Cold War/Pre-9/11 time period represents no major combat operations occurring, but the use of US military in stabilization operations. FY 2005 is represented as the highest annual requirement under the current force sizing construct (also known as the "1-4-2-1" Simultaneity Stack). Finally this table of ammunition requirements will identify the requirements during World War II. This time period reflects total mobilization of the US military and reflects a worst case scenario for the country. Elements of the current force-sizing construct used are swiftly defeating adversaries in two major combat operations; and the operating and generating forces developed to support the simultaneous operations in non-critical regions, as well as theater security agreements.[1] Full mobilization was selected as a demand criterion as it mobilizes the full force, minus mobilizing the industrial base.

Tables of cartridge commodity supply will identify the commodities required for each cartridge component, as well as LCAAP's primary and alternate sources of supply for each commodity. Next, tables of commodity supply sourcing will identify if the location of the source is US-based or Allied, the dedicated maximum production capability of each source of supply, and whether the source of supply requires commodity input[1]. Finally, these tables will illustrate the total supply chain represented in a wiring diagram. These criteria were selected to analyze the redundancy and responsiveness of the Lake City Army Ammunition Plant's commodity supply chain. By determining these elements, the author will determine the strength of the supply chain, and thus, the strength of LCAAP's capability of producing small arms ammunition.

The first step was to record the amount of ammunitions required by the US Army for two major combat operations, the requirements for supporting simultaneous operations in non-critical areas, as well as theater security agreements, the total training requirements for the generating force, and finally the small arms ammunition requirements for full mobilization. The next step was to record each cartridge component commodity, LCAAP's sources of supply for the identified commodity, whether the source is US based or Allied, the source's maximum production capability for the commodity, and whether the supplier requires outside sourcing for the manufacturing of the commodity. Next, the requirements from the table were added together and compared to the stated maximum production capability from the Lake City Army Ammunition Plant. Finally, the tables of commodity supply sources were compared together to

[1]The author will determine if the supplier relies on any outside sourcing to manufacture the stated commodity. If the supplier requires outside sourcing, this generates another table of commodity supply sourcing.

illustrate LCAAP's total supply chain for each munitions type. This analysis will determine if there are greater requirements than maximum LCAAP production capability, as well as determine how much greater production the supply chain can support.

Table 1. US Army Small Arms Ammunition Annual Requirements

Ammunition Type	Pre-9/11 Annual Requirements	FY 2005 Annual Requirements	WWII Total Mobilization Requirements
5.56mm			
7.62mm linked			
.50 caliber linked			
TOTAL			

Source: Table created by author (blank table for methodology)

The author will use table 1 to record the small arms ammunition requirements based on its selected criteria. This data will be annual maximum requirements, based on usage data. The researcher was unable to obtain current annual requirements due to their sensitivity and would not be released by the Joint Munitions Command. Fiscal Year 2005 was used as this year reflects the highest usage of small arms ammunition under the current ~~"1~~-4-2-1" force sizing construct. This will enable the reader to fully understand the maximum annual requirement for current and future operations.

Table 2. Small Arms Ammunition Management

Ammunition Type	Total Annual Requirements (FY 2005)	Maximum GOCO Annual Production
5.56mm		
7.62mm linked		
.50 caliber linked		
TOTAL		

Source: Table created by author (blank table for methodology)

Table 2 will compare the Fiscal Year 2005 requirements by small arms ammunition type against the maximum production at the Lake City Army Ammunition Plant. This analysis will show preliminary capability shortfalls only, if any. Finally, the total requirements for all three small arms ammunition types will be totaled and compared against the total maximum production at the Lake City Army Ammunition Plant. The table will not include any outside sourcing supply production capability, but this will be covered as well.

Table 3. Cartridge Commodity Supply

Component Commodity	Primary Source of Supply	Alternate Source of Supply	Alternate Source of Supply
Casing Commodities			
Propellant Commodity			
Bullet Commodities			
Primer Commodities			

Source: Table created by author (blank table for methodology)

The author uses table 3 to identify each commodity involved in manufacturing the four components of a cartridge. This will include the casing component, the propellant component, the bullet component, and the primer component. The author will then identify the primary and two alternate sources of supply for each identified commodity utilized by Alliant Techsystems at the Lake City Army Ammunition Plant. This identifies all commodities involved in making small arms ammunition, as well as understanding the redundancy of Alliant Techsystems supply chain.

Table 4. Commodity Supply Sourcing

Chemical	Primary Source of Supply	Country of Origin

Source: Table created by author (blank table for methodology)
Note: All Sources of Supply are US based companies

Table 4 analyzes the strength of Alliant Techsystems' supply chain in the production of small arms ammunition. Each source of supply will be identified by US or allied manufacturing distinction. This selected criterion will analyze the business security of the supply chain. The author believes a manufacturing operation located in the US or an Allied country is more apt to support the defense industrial base and not be influenced by political, physical and economical factors. The table will analyze the dedicated maximum production in terms of quantity and time to Alliant Techsystems. The researcher will illustrate by source of supply, the total dedicated amount of commodity and the time it takes to manufacture it. This enables the reader to understand the strength of the supplier by determining potential surge capabilities. Finally, the last criterion selected for table 4 identifies any outside inputs into manufacturing a certain commodity. If there are any outside inputs to the supplier, then it will generate an identical table illustrating the sources of supply for the identified input. Analysis will also determine points of origin for the identified commodity and any potential issues based on the physical, economical and political aspects of the country identified.

In summary, the author's methodology is based on identifying the small arms ammunition requirements based on the current force-sizing construct, training the generating force, non-critical areas and theater security agreements, as well as full mobilization. In Chapter 4, these requirements will be analyzed against the production capabilities of the Lake City Army Ammunition Plant. The production capabilities will also include any outside supply sources either identified or contracted by the Joint Munitions Command. Each commodity involved in the manufacturing of each cartridge component will be identified, along with the primary and alternate sources of supply.

Finally, the strength of the supply chain will be illustrated through the analysis of the sources of supply capabilities. It is the analysis of the requirements versus capabilities model that will properly answer the primary question: Can the industrial defense base support small arms ammunition production for the current and future operations, as well as the increase in force structure?

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[1]Department of Defense. *Quadrennial Defense Review Report* (Washington, DC: Government Printing Office, 2006), 3-5.

CHAPTER 4

ANALYSIS

> In the final analysis the most effective universal approach to decision making is to ask the right question at the right time. [1]
>
> --George A. Steiner

The purpose of this chapter is to provide a gap analysis between the US Army's small arms ammunition requirements and the industrial base's production capabilities. This analysis will answer the primary research question: Can the defense industrial base support small arms ammunition production for the current and future operations, as well as the increase in force structure? This chapter is organized by first introducing the total requirements for small arms ammunition as determined by the Joint Munitions Command. These requirements will represent time periods reflective of peacetime operations, current operations, and total mobilization during war. Next, the current defense industrial base's small arms ammunition production capability is presented in comparison to the requirements. Then the Lake City Army Ammunition Plant's supply chain is analyzed to determine potential points of failure and possible shortfalls. The author's interpretations of these results will be offered in the final chapter.

The answer to the primary research question is derived by answering the secondary questions. The first of which is: What are the current and future requirements for small arms ammunition? This answer is illustrated in table 5. This data represents the total requirements for small arms ammunition required by the US Army in three time periods. The first time period represents requirements based on peacetime operations and training occurring post-Cold War and pre-9/11. This time period reflects a similar force structure to today's Army, but during a period in which no major combat operations

occurred. The next time period represents requirements based on components of the ―1-4-2-1" Simultaneity Stack for Fiscal Year 2005. This fiscal year was selected as the author believes it provide a valid representation for current and future operations, as FY 2005 required the most small arms ammunition under the current force-sizing construct. This is also based upon the assumption the US Army requirements for Two Major Combat Operations will remain constant despite the announced drawdown of forces in Iraq, but the subsequent enlargement of forces in Afghanistan. Finally, the third time period selected was small arms ammunition requirements during World War II. Although the annual requirements do not reflect individual ammunition type data, the total annual requirements are identified. The researcher also found that current small arms ammunition requirements would not be relinquished by the Joint Munitions Command due to their sensitivity. The data was not able to be segregated into the types of usage, as this information was not available in clear fidelity.

Table 5. US Army Small Arms Ammunition Annual Requirements

Ammunition Type	Pre-9/11 Annual Requirements	FY2005 Annual Requirements	WWII Annual Requirements
5.56mm	626.2 million rounds	1.353 billion rounds	n/a
7.62mm linked	47.2 million rounds	282 million rounds	n/a
.50 caliber linked	20.4 million rounds	74 million rounds	n/a
TOTAL	693.8 million rounds	1.709 billion rounds	21.6 billion rounds

Source: Table created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

The total requirements for small arms ammunition represented by the three time periods clearly indicate the types of operations occurring. The first time period, pre-9/11, is indicative of the "peace dividend" brought about after the end of the Cold War, as well as a reduction in forces following the Gulf War. The US military and policy makers clearly believed in a smaller, more technologically-advanced force which could end conflict rapidly. The requirement for the production of large amounts of small arms ammunition was no longer needed. However, the simultaneous operations in Afghanistan and Iraq, classified in the force-sizing construct as two simultaneous major combat operations, changed the requirements for ammunition. Although the data does not reflect the usage for each small arms ammunition type, much of it was used in the training prior to deployment to these two operations. Again, Fiscal Year 2005 was used to represent the highest annual requirement under the current force-sizing construct. Finally, the researcher chose to represent data from World War II to highlight the worst case scenario requirements. This data represents total mobilization of the force during war. Although this "black swan"[2] is not necessarily a viable option for the current threats to the United States, the researcher believes in its validity in comparing small arms ammunition production capabilities.

The analysis of table 5 for small arms ammunition requirements also leads into the next secondary question to be answered: What defense industrial base production capability current exists? The production capability represented accounts only for the Government Owned, Contractor Operated facility located at the Lake City Army

[2]The term "black swan" represents a worst-case scenario in which the President of the United States authorizes total mobilization of the military, to include mobilizing the industrial base.

Ammunition Plant. It does not represent outside contracted sources of production. These contracted sources account for approximately 300 million rounds annually. The Joint Munitions Command currently has awarded contracts to General Dynamics Ordnance Tactical Systems as the second source supplier.[2] General Dynamics Ordnance Tactical Systems has procured contracts out through various sources to include Olin-Winchester. Prior to this current contract, the Joint Munitions Command has also acquired small arms ammunition from foreign sources such as the Israel Military Industries for similar amounts in 2005.[3] This outside sourcing of small arms ammunition was at a cost of more than $10 million more than what it would have cost if the Lake City Army Ammunition Plant possessed enough capability.[4]

The Lake City Army Ammunition Plant is operating at maximum production capability and will not be able to produce significantly more than the sum total represented in table 6. Current modernization efforts will last through FY 2011, but will not significantly increase the plant's production. Lake City also does not possess the ability to significantly increase the production of an ammunition type by refitting another ammunition type production line. This means Lake City cannot shut down the 7.62mm production line, transform it to produce 5.56mm, and gain 230 million additional rounds for 5.56mm. The only option to significantly increase small arms ammunition production at the Lake City Army Ammunition Plant would be to construct additional facilities and production lines.[5] At this time there are no current or future plans to construct additional facilities at the Lake City Army Ammunition Plant, nor are there any new construction planned at the other Government Owned, Contractor Operated plants located within the United States.

Table 6. Small Arms Ammunition Management

Ammunition Type	Total Annual Requirements (FY2005)	Maximum GOCO Annual Production
5.56mm	1.353 billion rounds	1.2 billion rounds
7.62mm linked	282 million rounds	230 million rounds
.50 caliber linked	74 million rounds	85 million rounds
TOTAL	1.709 billion rounds	1.515 billion rounds

Source: Table created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

Analysis was also conducted on the Lake City Army Ammunition Plant's supply chain for each small arms ammunition cartridge type. Prior to conducting a site visit an interview with the Lake City staff, the author believed the key commodities used to manufacture each caliber component differed. However, upon interviewing the Alliant TechSystems Purchasing Department at Lake City, the author discovered each component utilized the same key commodities. There are differences in the sources of supply for each of these commodities specific to each cartridge type. This is represented in table 7.

Table 7. Cartridge Commodity Supply

Component Commodity	Primary Source of Supply	Alternate Source of Supply	Alternate Source of Supply
Casing Brass	Olin Brass	Luvauta Brass Co.	DN Presstec
Propellant	St. Marks Powder	n/a	n/a
Bullet Lead	Metalico-Granite City	Gopher Resource Corporation	Exide Corporation
Bullet Steel Penetrator	Michigan Rod Products	Greene, G.G	n/a
Primer	Alliant TechSystems	n/a	n/a
Primer Mix	There are 17 chemicals involved in the primer mix, all of which have different suppliers		

Source: Table created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

Table 7 illustrates each key commodity involved in manufacturing the cartridge components and the sources of supply utilized by Alliant TechSystems at the Lake City Army Ammunition Plant. Each small arms ammunition type uses brass as the material to manufacture the cartridge casing. Alliant TechSystems purchases over 95 percent of casing brass from the Olin Brass Company in the form of brass case cups and bullet jacket cups. This purchase agreement is a fixed price, fixed time agreement. Olin Brass Company also supplies US-based commercial ammunition manufactures with brass sheet metal for cartridge casings.[6] During the FY 2005 production surge, Olin Brass Company was able to meet the increased demands without causing any disruption of small arms ammunition production at the Lake City Army Ammunition Plant. Alliant TechSystems also purchases brass from DN Presstec for two cartridge types. This company is located

in Germany. Another alternate supplier for brass is the Luvauta Brass Company in Buffalo, New York. This supplier was recently solicited for a four-year proposal from Alliant TechSystems, but did not bid.[7] Research on this commodity did not find any issues with supplying Alliant TechSystems with the materiel needed to produce the case component for each small arms ammunition cartridge type.

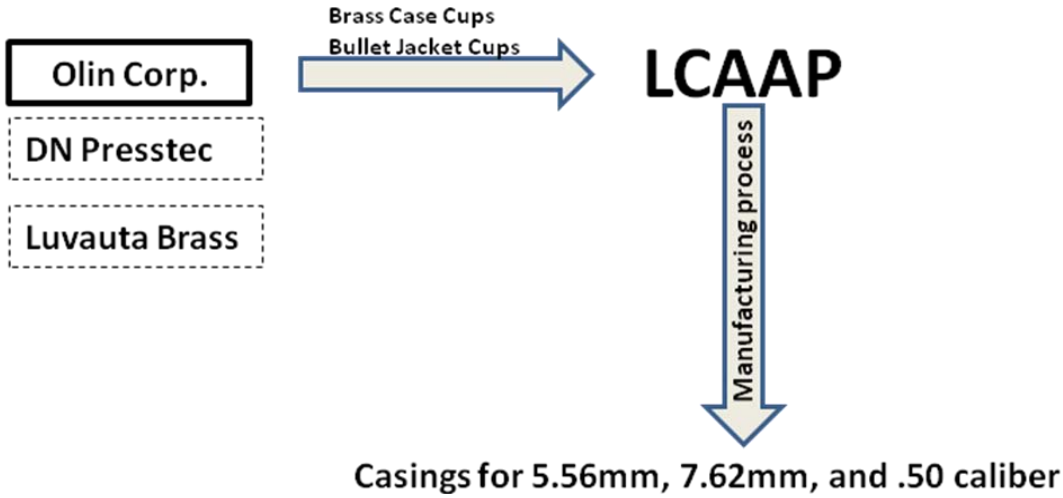

Figure 11. Brass Casing Supply Chain
Source: Figure created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

Alliant TechSystems identifies St. Marks Powder as the primary source of supply for the propellant used in each of the small arms ammunition types. Based in Tallahassee, Florida, this General Dynamics Company is the single source of propellant for the Lake City Army Ammunition Plant. Alliant TechSystems continues to research effective substitutes, but has found none due to US government risk mitigation policies, as well as US government production quality and quantity standards. Research data on propellant

did present an issue with one of the key commodities and its source of supply. This commodity is nitrocellulose and is found in every propellant and explosive used by the US military from small arms ammunition to bombs. The only manufacturer capable of producing the quantity and quality required by the US military is the Radford Army Ammunition Plant in Virginia. Its acid concentrator produces the nitric and sulphuric acid solution that is combined with cellulose to produce nitrocellulose. A modernization program at Radford is constructing a new acid concentrator and plans to construct a new nitrocellulose facility will begin between 2011 and 2013.[8] Research does not indicate an increase in the production capability of nitrocellulose at the Radford Army Ammunition Plant with this new facility.

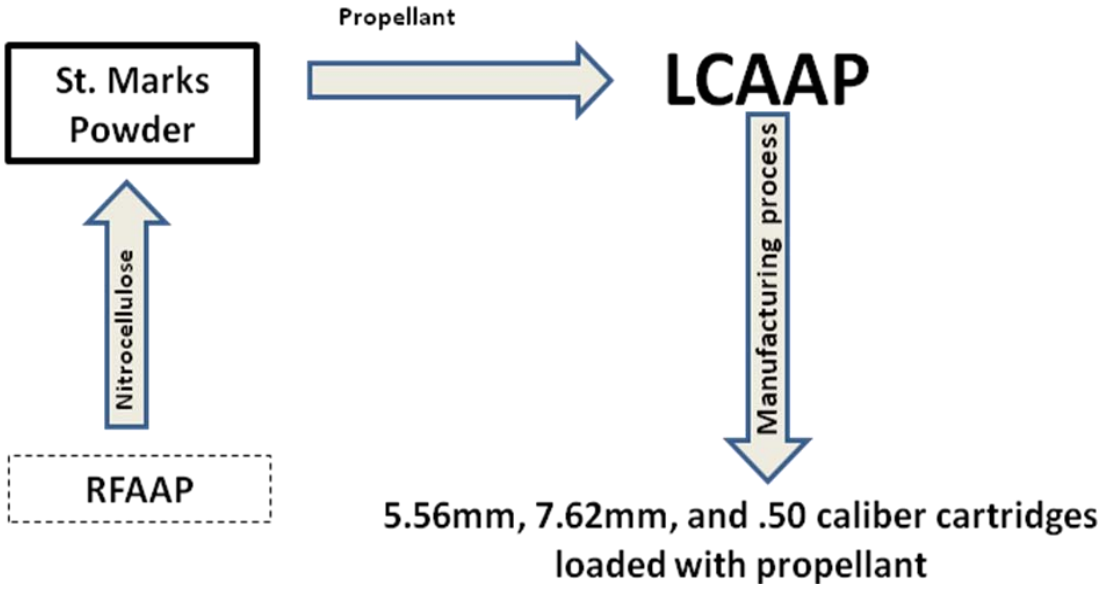

Figure 12. Propellant Supply Chain
Source: Figure created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

The next key commodity for each cartridge is the lead used in manufacturing the bullet. Alliant TechSystems identifies three suppliers of lead, all of which are located within the continental United States. The primary supplier uses a proprietary technique to extract lead from used vehicle batteries, and then reformulated to be sold. The lead is purchased in ingots then configured at Lake City for each cartridge. No supply issues exist in the purchasing of lead for the bullet cartridge component. Alliant TechSystems was certain a cost increase would not occur if it chose to utilize other sources of supply for lead. Also, the author did not research data on the US Army's initiative of developing a lead-free bullet.[9] This research was identified in Chapter Five as a potential future study for the US Army.

Another key commodity for the bullet is the steel penetrator for each cartridge type. Again, Alliant TechSystems identified two main sources of supply for this key commodity. These suppliers acquire steel from various sources throughout the world. This particular commodity does not experience any supply issues for the Lake City Army Ammunition Plant from the two main vendors. Alliant TechSystems has also identified other sources of supply for the steel penetrator.[10]

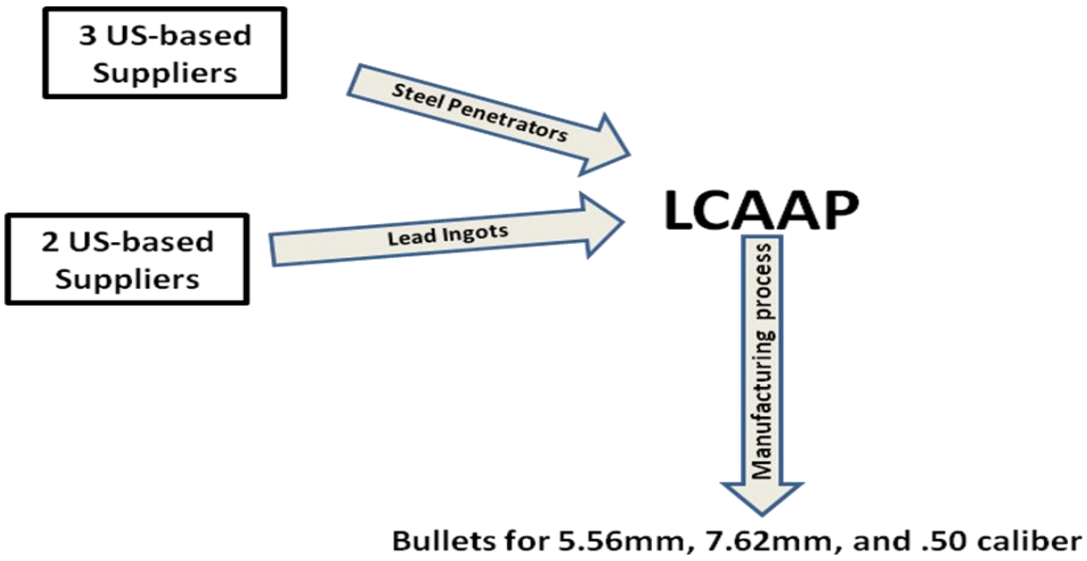

Figure 13. Bullet Components Supply Chain
Source: Figure created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

The final key commodity in manufacturing cartridges is the primer and the primer mix. All small arms ammunition manufactured at the Lake City Army Ammunition Plant receive primers from a on-site manufacturing facility. There are over forty Alliant TechSystems facilities that can provide primers to the Lake City plant.

Table 7 identifies the primer mix chemicals, the suppliers to Alliant TechSystems, as well as the country of origin. These thirteen chemicals are involved in the manufacturing of the primer mix at the Alliant TechSystems facilities. All thirteen chemicals are formulated by US-based commercial companies, but ten chemicals have origins outside of the United States. Of these ten identified chemicals, four only have origins in China, two more are only found in Mexico, and one only originates in Brazil. Three more chemicals share origins among the United States, Europe, India, China, and Mexico. Despite the commodities having origins outside of the continental US, Alliant

TechSystems has not identified any of these commodities as having a supply problem to the formulator.[11] This research does find potential issues with the countries of origin for some of the identified chemicals. These potential issues are primarily political in nature. Although trade agreements do exist with China and India, these countries may represent adversaries in the future. This adversarial relationship may very well become a reality in the current global economic state due to economic protectionist policies becoming enacted by the US Congress Recently, a minor trade disagreement between the US and China began over the increase in the tariff on tires imported from China.[12] Although this measure by the Office of the United States Trade Representative was meant to protect the US tire industry, it may push China to reciprocate tariff action. The worst case scenario is a repeat of the Smoot-Hawley Tariff Act of 1930 that President Hoover signed on the eve of the Great Depression. The effects of this tariff caused other nations to impose large tariffs, which in turn, caused more unemployment due to US companies not being able to sell their products abroad. Many economic analysts believe the ensuing retaliatory tariffs by US trade partners contributed to the severity of the Great Depression.[13]Despite the economic impacts of global trade wars, the US defense industry cannot afford a disruption of key commodities from China and India with the current small arms ammunition cartridge design utilized. The alternative choices in order to not depend on outside sources for key commodities are simple. Either the defense industrial base takes active measures to purchase and stockpile these chemicals, or research and development must develop a cartridge that does not contain these chemicals. Research was not undertaken on the commodities involved in small arms ammunition produced prior to the current design.

The chemicals found in Mexico may be classified as potential issues as the government of Mexico continues to struggle with native indigenous groups and drug cartels.

Table 8. Primer Mix Chemicals

Chemical	Supplier	Country of Origin
Barium Nitrate	Barium & Chemicals	China
Calcium Silicide	Perkins Rouge	Brazil
Magnesium Oxide	Matrixchem	Mexico
Calcium Resinate – Fused	Barium & Chemicals	USA/China/Europe/India
Potassium Perchlorate	Hummel Crouton	China
Strontium Nitrate	Barium & Chemicals	China
Strontium Oxalate	Barium & Chemicals	USA/China/Europe/India
Strontium Peroxide	Hummel Crouton	Mexico/USA
Magnesium Aluminum Alloy	Reade Mfg.	USA
Calcium Resinate – Peripiated	Hummel Crouton	Mexico
Magnesium Carbonate	Matrixchem	USA
Barium Nitrate	Barium & Chemicals	China
Ammonium Nitrate	Dyno Nobel	USA

Source: Table created by author, data from Alliant TechSystems Purchasing Department, Lake City Army Ammunition Plant, Independence, MO.

In summary, the small arms ammunition requirements for the US Army outweigh the industrial base's organic capability to produce an equal amount at the only government-owned, contractor-operated facility located at the Lake City Army Ammunition Plant. Although modernization programs are being implemented, they will not significantly increase the sole government-owned, contractor-operated small arms ammunition plant's capability to produce enough ammunition to meet the requirements of the US Army. This shortfall in production capability has forced the Joint Munitions Command to award additional sourcing contracts to General Dynamics for approximately 300 million additional small arms ammunition rounds. This shortfall is extremely exposed in the advent of total conventional war requirements based on historical World War II data. Despite the efforts of the Joint Munitions Command, the Lake City Army Ammunition Plant and the contract with General Dynamics Ordnance Tactical Systems will not be able to deliver enough small arms ammunition in this type of scenario. Capability to produce enough ammunition does not currently reside in the United States due to the deactivation of ammunition plants and the subsequent sale of manufacturing equipment, much of which ended up in foreign countries.[14] The United States would also, most likely, not be able to rely on foreign and allied nations for small arms ammunition support in this scenario.

In addition, several key commodities were identified for the cartridge components. Alliant TechSystems has identified and researched primary and alternate sources of supply for these commodities, as well as any existing supply problems. Of these sources of supply, only the down trace suppliers for the primer mix pose any potential issues. These issues revolve around the origination of the chemical material in

countries such as China, India, and Mexico. Although current trade agreements do not restrict the availability of these chemicals, these chemicals are only found in these countries. They, in effect, maintain a monopoly on the identified chemicals. Thus, the small arms ammunition supply chain does not have alternatives for these key commodities. Any disruption of the supply chain, whether economic, political, or physical, will have significant adverse effects on the defense industrial base to produce small arms ammunition. The defense industrial base must prepare for any disruption in the supply chain by either stockpiling these identified key chemicals, or it must design a new cartridge which does not rely on the chemicals for manufacture.

Research also indicated an inability or failure on the part of Alliant TechSystems to fully understand their suppliers total dedicated surge capability. This information would be useful in understanding the limit of surge capability of the defense industrial base if it indeed possessed the capability to manufacture more small arms ammunition. As was experienced in Fiscal Year 2004, when the small arms ammunition requirements almost doubled, the defense industrial base had to react. In order to avert another potential area of supply disruption, Alliant TechSystems must define their supply chain's total maximum dedicated capability.

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[1]George A. Steiner, *Strategic Planning, What Every Manager Should Know,* New York, NY: Free Press Paperbacks, 1979), 192.

[2]Laurie VanBrocklin, *General Dynamics Awarded Small Arms Ammunition Contract,* http://www.pressmediawire.com/article/Investor_Relations/Contracts/General_Dynamics_Awarded_109_Million_by_US_Army_for_SmallCaliber_Ammunition/18371 (accessed 22 October 2009).

[3]Independent News and Media (UK) Ltd., 2005, www.commondreams.org/headlines05/0925-02.htm (accessed 21 October 2009).

[4]Ibid.

[5]Day.

[6]Smith.

[7]Ibid.

[8]Justine Barati, JMC (AMC). *Radford Looks to New Plant,* http://www.army.mil/-news/2009/01/22/15990-radford-looks-to-new-plant/ (accessed 4 September 2009.

[9]Smith.

[10]Ibid.

[11]Ibid.

[12]The Daily Finance, *US Imposes Big Tariffs on Chinese Tires, Beijing*, 12 September 2009, http://www.dailyfinance.com/2009/09/12/us-imposes-big-tarriffs-on-chinese-tires/ (accessed 2 November 2009).

[13]Encyclopedia Britannica, *Smoot-Hawley Tariff Act*, http://www.britannica.com/EBchecked/topic/550096/Smoot-Hawley-Tariff-Act (accessed 2 November 2009).

[14]Smith.

CHAPTER 5

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

> Ironically in our history we have eliminated the industrial base after the conflict, and then shortly thereafter had to reestablish the base at great sacrifice.[1]
>
> Dr. Edward C. Ezell, Smithsonian Institute

Conclusions

Primary Research Question

Can the defense industrial base support small arms ammunition production for the current and future operations, as well as the increase in force structure? The answer to this question is yes. Despite the evidence demonstrating that the only government-owned, contractor-operated production facility cannot produce enough small arms ammunition to meet the requirements, the Joint Munitions Command acquisition strategy covers the capability gap with additional sourcing. It is these additional 300 million rounds annually that allow the defense industrial base to meet the requirements. However, the research clearly shows that this additional sourcing cannot replace the quantity produced at the same quality as the Lake City Army Ammunition Plant. Furthermore, the modernization programs at Lake City cannot increase production capability to solely meet the requirements either, not without building additional facilities and production lines. The Joint Munitions Command's current acquisition strategy is based on the current "4-2-1" force-sizing construct. This force sizing construct is not expected to change significantly upon publication of the Quadrennial Defense Review in February 2010. However, it will not include requirements for total mobilization of the military. The presented historical data from World War II is evident of the greater requirement during total conventional war. Despite this scenario not being necessarily viable in the current global threat

analysis, it clearly shows an inability of the defense industrial base to support and sustain the United States Army. The defense industrial base is not capable of activating any previously used ammunition production facilities to support total conventional war requirements.

The research on Alliant TechSystems' supply chain operations at the Lake City Army Ammunition Plant shows a strong and stable supply of commodities needed for the manufacturing of each small arms ammunition type. This will continue to be the case unless those commodities originating in foreign countries, such as China and Mexico, are somehow threatened physically, economically or politically.

Implications

The implications of this study are that the small arms ammunition requirements set forth by the Joint Munitions Command are met through the combined capabilities of the Lake City Army Ammunition Plant and additional sources of supply. The data clearly points out that the Lake City Army Ammunition Plant has not and cannot produce the total requirements for small arms ammunition. This shortfall in GOCO production capability as compared to the US Army's requirements, has forced the Joint Munitions Command to subsequently award second source supplier contracts to General Dynamics Ordnance Tactical Systems. As mentioned previously, these contracts are for the annual production of approximately 300 million rounds of small arms ammunition. General Dynamics acquires this ammunition through US-based commercial companies, as well as foreign companies.

The implications of second- and third-order effects would be that any significant and prolonged damage or degradation of the Lake City Army Ammunition Plant's

production capability may result in the culmination of the US Army's operations around the world–if the small arms ammunition requirements remained constant or increased. This potential flaw is a consequence of the US Army logisticians' ability to become every increasingly efficient.

Other potential fatal flaws center on cartridge component commodities and material origination. All ammunition roads lead from the Radford Army Ammunition Plant based on its uniqueness of being the sole government-grade producer of nitrocellulose. Although modernization programs will supplant the aging facility currently used, the US Army and military cannot afford to lose this plant's ability to produce nitrocellulose in such great quantities with great quality. Again, any prolonged decrease in production capability results in culmination of US forces.

Finally, the research showed a potential flaw with material for cartridge component commodities originating in potentially adversarial countries like China and India. These countries of origin are potential flaws based on the US solely relying on these countries to provide the identified chemicals. Although the US continues to take strides in improving relations with these countries, both politically and economically, it continues to be an issue of sole reliance. Alliant TechSystems continues to research additional sources of supply, but are limited to certain chemicals unless a different cartridge type is invented and economically produced.

The Army can continue to rely on the defense industrial base to provide it with the quality and quantity of small arms ammunition to fight and win this nation's wars. But, the defense industrial base must continue to enhance its own capabilities and prepare for unanticipated events that may lead it to become less reliant on external sources.

The case has been made that the current small arms ammunition acquisition strategy works to get it into the hands of the Soldier. However, the success of the current production capability has allowed the defense industrial base to put ~~a~~ll of its eggs into one basket."

Recommendations

The researcher recommends that the Joint Munitions Command conduct a viability study to construct new government owned small arms ammunition production facilities. Whether these are government operated or contractor operated need not be an issue. However, logisticians and warfighters alike must be cognizant of the principle of redundancy in the strategic supply system. As stated previously, the success of the small arms ammunition production at the Lake City Army Ammunition Plant has created an issue of world-wide operational degradation if prolonged damage or a decrease in capability occurs. From interviews with the facility commander and Alliant TechSystems staff, it is increasingly important this cannot occur if American military power is to continue its world-wide presence.

The researcher also recommends comparative analysis be conducted on small arms ammunition current design as compared to World War II design. The benefit of this analysis would determine the need of key commodities and chemicals currently involved in the manufacture of small arms ammunition. This analysis is needed based on current reliance of chemicals originating in potentially adversarial countries.

Recommendations for Future Research

–There are moments when everything is going well; don't be frightened; it won't last." [2]

The research discovered several other areas that are recommended for future studies.

1. One recommendation is to conduct a study of the numerous single points of failure in the aging Lake City Army Ammunition Plant.

2. Another recommendation is to study the economic viability of researching and developing a lead-free bullet. Data was discovered that would point out numerous supply issues utilizing other precious metals and commodities.

3. Another interesting study would be to harvest actual usage of small arms ammunition with the procured amount designated by the Joint Munitions Command.

While there have been numerous recommendations that will contribute to better small arms ammunition production capability, success will only come from within the Army staff structure. It must be the senior military leaders and government civilians alike to be able to integrate their actions and capabilities into synchronized actions.

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[1]LTC Donald D. Whitfield, US Army. *The Ammunition Production Base –Past, Present, and Future* (Washington, DC: National Defense University. 1993), 5.

[2]A. L. Selmon, –Modernization of Army's Munition Production Base," *Defense Management Journal* (October 1974), 2.

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